CHAPTER 3

DISTRIBUTION MAINS

3-1. Main sizes. Maximum and minimum distribution systems pressure requirements are given in chapter 4. Distribution system hydraulic analysis are given in appendix B. Water distribution mains of various materials are readily available in sizes ranging from 6 to 48 inches inside diameter; large pipes up to 144 inches and greater can be specially made. Minimum diameter for distribution mains and fire branches is 6 inches.

a. Domestic requirements. The system should be capable of delivering the peak domestic demand as described in TM 5-813-1/AFM 88-10, Volume 1, plus any special requirements, at pressures not lower than 30 pounds per square inch at ground elevation. The required daily demands should be determined by calculating the effective populations of various areas to be served and applying the appropriate per capita water allowances (TM 5-813-1/AFM 88-10, Volume 1). Guidance on the estimation of demands at special projects is given in TM 5-813-7/AFM 88-10, Volume 7. For small installations not having elevated storage, the peak domestic demand will be determined on a fixture basis (TM 5-810-5/AFM 88-8, Volume 4).

b. Fire Flows. The distribution system will be designed to deliver the necessary fire flow requirements, the required daily demand (TM 5-813-1/AFM 88-10, Volume 1), and any industrial or special demands which cannot be reduced during a fire. When only hose streams are supplying the required fire flow streams, residual ground level water pressures at fire hydrants should be not less than 10 pounds per square inch. If sprinkler systems are used, residual pressures adequate for proper operation of the sprinkler systems must be maintained. Specific guidance as to fire flows and pressure required for various structures and types of fire protection systems is given in AFM 88-10, Chapter 6 for Air Force applications and MIL-HDBK-1008 for Army applications.

c. Friction losses. In computing head losses due to friction in a distribution system, the Hazen-Williams formula, as given below, will be used.

$$V = 1.318\, CR^{0.63} S^{0.54} \qquad \text{(eq 3-1)}$$

where

V = the mean velocity of the flow, in feet per second.

R = the hydraulic radius of the pipe in feet, i.e., the cross-sectional area of a flow divided by the wetted perimeter of the pipe. For a circular pipe flowing full, the hydraulic radius is equal to one-fourth the pipe diameter.

S = the friction head loss per unit length of pipe (feet per feet).

C = a roughness coefficient, values of which depend on the type and condition of pipe. Typical values of this coefficient are shown in table 3-1.

Table 3-1. Pipe materials and valves

Pipe Material	C
Concrete (regardless of age)	130
Cast iron:	
New	130
5 years old	120
20 years old	100
Welded steel, new	120
Wood stave (regardless of age)	120
Asbestos-cement	130
Plastic (PVC, Fiberglass)	130

Values as high as 150 are claimed for plastic pipe. The values shown in table 3-1 are considered practical limits because of losses that may result due to fittings and valves, and because of improper installation. Hydraulic analyses will normally be made using a value of 100 for the roughness coefficient. However, consideration should be given to the use of coefficients greater than 100 when specifying concrete, asbestos-cement, or plastic pipe under conditions that experience has shown will not seriously reduce the carrying capacity of these pipes, within the anticipated economic life of the project. Coefficients greater than 130 should not be used. In some cases, expansions to existing distribution networks, rather than entirely new networks, must be planned. In such instances, it may be desirable to determine the roughness coefficients of the existing pipelines through a series of coefficients tests. These involve isolating sections of pipeline to the greatest extent possible, measuring the flow through the pipelines, and monitoring the changes in the hydraulic gradient between different points on the same pipes. This information can be used to derive the friction head loss per unit length of pipe, and, in turn, a roughness coefficient can be calculated.

d. Fire-hydrant branches. Fire-hydrant branches (from main to hydrant) should not be less than 6 inches in diameter and as short in length as possible, preferably not longer than 50 feet with a maximum of 300 feet.

3-2. Location of mains.

a. General. Mains should be located along streets in order to provide short hydrant branches and service connections. Mains should not be located under paved or heavily traveled areas and should be separated from other utilities to ensure the safety of potable water supplies, and that maintenance of a utility will cause a minimum of interference with other utilities.

b. Distribution system configuration. The configuration of the distribution system is determined primarily by size and location of water demands, street patterns, location of treatment and storage facilities, and topography. Two patterns of distribution main systems commonly used are the branching or dean end, and gridiron patterns.

(1) *Branching system.* The branching system shown in figure 3-1 evolves if distribution mains are extended along streets as the service area expands. Dead ends in the distribution system are undesirable and should be avoided to the extent possible.

(2) *Gridiron system.* The second distribution configuration is the gridiron pattern shown in figure 3-1. The gridiron system has the hydraulic advantage of delivering water to any location from more than one direction, thereby avoiding dead ends. The use of a gridiron pattern looped feeder system is preferable to the use of a gridiron pattern with a central feeder system because the looped feeder supplies water to the area of greatest demand from at least two directions. A looped feeder system should be used for water distribution systems whenever practicable. Although it is advantageous to have all water users located within a grid system, it is often impracticable to do so. Water is normally delivered to a remote water user, or a small group of users, by a single distribution main. Therefore, the majority of the water users are served within a gridiron system while the outlying water users are served by mains branching away from the gridiron system. Branching mains should be avoided to the greatest extent possible.

c. Horizontal separation between water mains and sewers. Water mains should be laid horizontally, a minimum of 10 feet, from any point of existing or proposed sewer or drain line. Water mains and sewers must not be installed in the same trench. If any conditions prevent a horizontal separation of 10 feet, a minimum horizontal spacing of 6 feet can be allowed, but the bottom of the water main must be at least 12 inches above the top of the sewer. Where water mains and sewers follow the same roadway, they will be installed on opposite sides of the roadway, if practicable.

d. Water main sewer crossings. Where water mains and sewers must cross, the sewer will have no joint within 3 feet of the water main unless the sewer is encased in concrete for a distance of at least 10 feet each side of the crossing. If special conditions dictate that a water main be laid under a gravity-flow sewer, the sewer pipe should be fully encased in concrete for a distance of 10 feet each side of the crossing, or should be made of pressure pipe with no joint located within 3 feet horizontally of the water main, as measured perpendicular to the water main. Pressure sewer pipe shall always cross beneath water pipe and a minimum vertical distance of 2 feet between the bottom of water pipe and the top of pressure sewer pipe shall be maintained. The sewer must be adequately supported to prevent settling.

e. Protection in airfield pavement areas. Water mains should not be located under airfield pavement areas if other locations are available and economically feasible. Special protection of the mains are required when alternative locations are not available and it is necessary to locate water mains under pavement areas on which aircraft move under their own power. The amount of protection needed is dependent upon the importance of maintaining a supply of water to the area served by the main, and on the availability of emergency water supplies to the affected area. The degrees of protection should be considered as follows:

(1) *Minimum protection.* The water main must be enclosed in a vented, open-end, outer conduit from which the main can be removed for repairs or replacement. The outer conduit must have sufficient strength to support all foreseeable loadings.

(2) *Intermediate protection.* Intermediate protection requires the water service to be carried under the airfield pavement by dual waterlines enclosed in an outer conduit or, preferably, in separate conduits.

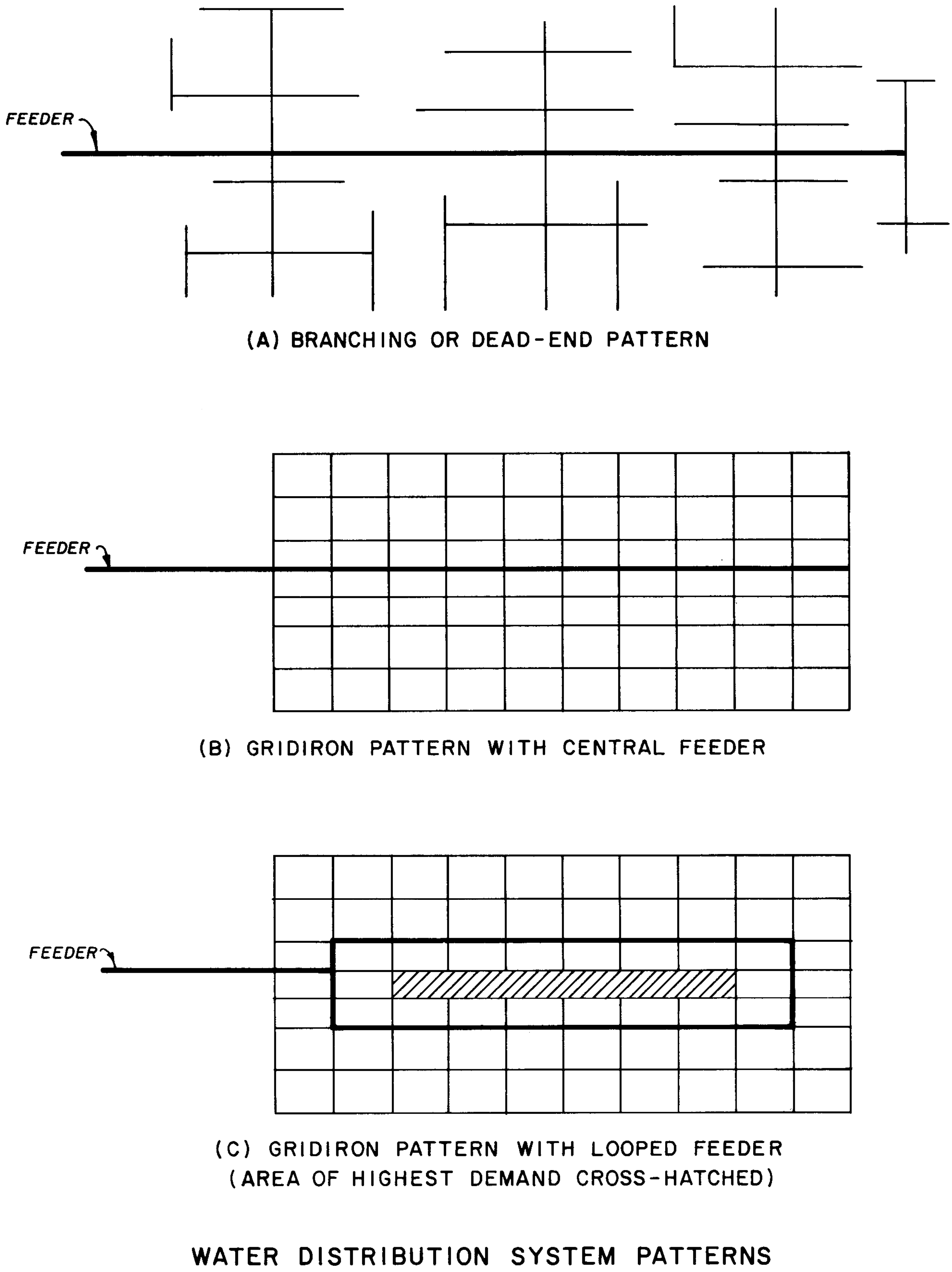

Figure 3-1. Water distribution system patterns.

(3) *Maximum protection.* Where more than one utility crosses the airfield pavement and individual crossings would be more expensive than a combined crossing, the utilities will be enclosed in a utility tunnel of sufficient size for in-place repairs. Special precautions must be taken in the placement and protection of individual utility lines within the tunnel to ensure that failure of one utility does not affect the service of the others. Special protection of mains is not required where the mains are located beneath pavement areas that are not normally subject to the movement of aircraft under their own power, such as hangar access aprons on which aircraft would be towed.

3-3. Dual water supplies.

a. Applicability. Dual water supply systems consist of independent pipe networks supplying two grades of water to users. The higher quality water is used for domestic purposes such as drinking, cooking, dishwashing, laundry, cleaning, and batching; the lower quality water may be used for toilet flushing, fire fighting, lawn and garden watering, and commercial or industrial uses not requiring high quality water. Dual water supply systems are not feasible except under unusual circumstances. A dual water supply might be utilized when the only available water supply is brackish and the cost of a dual system is less than the demineralization cost of all the water supplied to users; or when only a limited quantity of higher quality water is available, and it is more economical to construct a dual system than to implement the required treatment of the lower quality water. If a dual water supply system is established and the lower quality water use might result in human contact or ingestion (e.g., toilet flushing, lawn and garden watering), both water supplies must be disinfected.

b. Evaluation of dual water supply system. The design of dual water supplies will be determined using results of feasibility studies which have substituted all engineering, economic, energy, and environment factors. If a dual water supply system is installed and a brackish water is used as the lower quality water, metallic pipes and plumbing facilities exposed to the brackish water may have considerably short lifespans than similar facilities exposed to water of better mineral quality. There will be no connection between the two pipe networks of a dual distribution system.

3-4. Recycling used water. There are operations that generate effluent water than can be reused for the same operation after minimal treatment. This does not constitute a dual system. Examples of such effluents are laundry wastes, vehicle washrack waste water, and plating operations waste water. Recycling of such water should be practiced wherever feasible.